

CLAIMS

1. An apparatus for delivering ions to a vacuum chamber comprising:
an enclosing ionization chamber including an ionization region and a vacuum interface
5 at a vacuum interface voltage, wherein the vacuum interface allows the ionization chamber to communicate with the vacuum chamber;
an electrospray assembly at approximately ground potential having a dispensing end disposed within the ionization chamber;
a first electrode disposed sufficiently close to the dispensing end at a first electrode
10 voltage of sufficiently high magnitude to form ions in the ionization region and to attract the ions from the ionization region;
a second electrode disposed in the ionization chamber at a second electrode voltage that repels the ion to a greater degree than the first electrode voltage; and
means for generating a gaseous stream in a gas flow path extending from the first
15 electrode to the second electrode, wherein the gaseous stream provides the ion with sufficient velocity to overcome repulsion by the second electrode,
wherein the vacuum interface voltage is more attractive to the ion than the second electrode voltage.
- 20 2. The apparatus of claim 1, wherein the first electrode includes a first electrode aperture and the gas flow path extends from the first electrode aperture to the second electrode.
- 25 3. The apparatus of claim 1, wherein the second electrode includes a second electrode aperture and the gas flow path extends from the first electrode to the second electrode aperture.
- 30 4. The apparatus of claim 1, wherein the first and second electrodes each comprise a flat surface substantially parallel to each other.
5. The apparatus of claim 4, wherein the gas flow path is substantially orthogonal to the flat surfaces of the first and second electrodes.

6. The apparatus of claim 1, wherein the vacuum interface communicates with the vacuum chamber in a direction that intersects with the gas flow path.

7. The apparatus of claim 6, wherein the direction is substantially orthogonal to the gas flow path.

8. The apparatus of claim 1, wherein the first electrode, the second electrode, or both comprise a mesh portion.

9. The apparatus of claim 1, wherein the vacuum interface comprises an aperture in a plate.

10. The apparatus of claim 1, wherein the vacuum interface comprises a conduit having an axial bore.

11. The apparatus of claim 10, wherein the conduit is metallic.

12. The apparatus of claim 10, wherein the conduit is substantially electrically insulating.

13. The apparatus of claim 10, wherein the axial bore has a diameter of capillary dimension.

14. The apparatus of claim 1, wherein the means for generating a gaseous stream represents a component of the electrospray assembly.

15. The apparatus of claim 1, wherein the first and second electrode voltages have opposite polarity.

16. The apparatus of claim 1, wherein the first electrode voltage is positive.

17. The apparatus of claim 1, wherein the first electrode voltage is negative.

18. The apparatus of claim 1, wherein the interface voltage is approximately at ground.

19. The apparatus of claim 1, wherein the ionization chamber is electrically connected to the electrospray assembly.

20. The apparatus of claim 1, wherein the ionization chamber is at approximately atmospheric pressure.

21. The apparatus of claim 1, further comprising a scupper electrically attached to a downstream surface of the second electrode.

22. The apparatus of claim 21, wherein the scupper is at least partially constructed of mesh.

23. A method for delivering ions to a vacuum chamber comprising:

(a) providing:

(i) an enclosed ionization chamber including an ionization region;

(ii) an electrospray assembly having a dispensing end at approximately ground potential disposed within the ionization chamber; and

(iii) a vacuum interface that provides communication between the ionization chamber and the vacuum chamber;

(b) injecting a sample from the electrospray assembly into the ionization region;

(c) charging a first electrode within the ionization chamber to a sufficiently high ion-attractive voltage to produce a sample ion in the ionization region;

(d) producing gas flow in a path extending from the first electrode to a second electrode having a second electrode voltage to transport the ion away from the first electrode and past a second electrode, wherein the second voltage is more repulsive to the ion than the first electrode voltage; and

(e) maintaining the vacuum interface at an interface voltage that is more attractive to the ion than the second electrode voltage such that the sample ion travels through the vacuum interface and into the vacuum chamber.

24. The method of claim 23, wherein the first electrode includes a first electrode aperture and the gas flow path extends from the first electrode aperture to the second electrode.

5 25. The method of claim 23, wherein the second electrode includes a second electrode aperture and the gas flow path extends from the first electrode to the second electrode aperture.

10 26. The method of claim 23, wherein the first and second electrodes each comprise a flat surface wherein the surfaces are substantially parallel to each other.

15 27. The method of claim 26, wherein the gas flow path is substantially orthogonal to the flat surfaces of the first and second electrodes.

20 28. The method of claim 23, wherein the vacuum interface communicates with the vacuum chamber in a direction that intersects with the gas flow path.

25 29. The method of claim 28, wherein the direction is substantially orthogonal to the gas flow path.

30 30. The method of claim 23, wherein the first electrode, the second electrode, or both comprise a mesh portion.

35 31. The method of claim 23, wherein the vacuum interface comprises an aperture in a plate.

40 32. The method of claim 23, wherein the vacuum interface comprises a conduit having an axial bore.

45 33. The method of claim 32, wherein the conduit is metallic.

34. The method of claim 32, wherein the conduit is substantially electrically insulating.

35. The method of claim 32, wherein the axial bore has a diameter of capillary dimensions.

36. The method of claim 23, wherein the gas flow is produced by a component of the electrospray assembly.

37. The method of claim 23, wherein the first and second electrode voltages have opposite polarity.

38. The method of claim 23, wherein the first electrode voltage is positive.

39. The method of claim 23, wherein the first electrode voltage is negative.

40. The method of claim 23, wherein the interface voltage is approximately at ground.

41. The method of claim 23, wherein the ionization chamber is electrically connected to the electrospray assembly.

42. The method of claim 23, wherein the ionization chamber is at approximately atmospheric pressure.

43. The method of claim 23, further comprising providing a scupper electrically attached to a downstream surface of the second electrode.

44. A method for delivering ions to a vacuum chamber comprising:
(a) providing first, second, and third electric field regions in an ionization chamber, wherein each region has a direction;
(b) producing ions from a sample dispensed by an electrospray assembly at approximately ground potential into the ionization chamber; and

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(ii) a second angle with respect to the second electric field direction when the ions are in the second electric field region; and

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wherein the first and third angles are each no greater than 90° and the second angle is greater than 90° .